

Charcoal as a capture material for silver nanoparticles in the aquatic environment

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Background: The reported antibacterial activity of silver nanoparticles (AgNPs) has led to their incorporation into numerous consumer products including; textiles, domestic appliances, food containers, cosmetics, paints, medical and medicinal products. The AgNPs incorporated into these products can be released into the environment and aquatic system during their production, use and end of life disposal. In the aquatic environment, uncertainties surround the concentration, fate and effects of AgNPs. The aim of this project is to examine charcoal as a potential material for capture of silver nanoparticles from the aquatic environment.

Material/methods: Activated charcoal is a commonly used filter material and was selected for this project to determine its suitability as a capture material for AgNPs in water samples. Activated charcoal (Norit® CA1 (Sigma-Aldrich)) was exposed to 100 ppb, 25 nm PVP coated AgNPs (nanoComposix) prepared in Milli-Q water. These solutions were exposed to unaltered charcoal granules for 20 hours after which the decrease of silver in the solution was measured using ICP-MS. In order to improve the removal, the surface area of the charcoal was increased firstly by grinding with a pestle and mortar and secondly by milling the charcoal. The milled charcoal was prepared using an agate ball mill running at 500 rpm for 5 minutes. The activated charcoal was then exposed to samples containing 10 ppb AgNPs.

Results: In the initial tests, approximately 10% of the silver was removed from the water samples using the unaltered activated charcoal granules. Further experiments were carried out to compare the unaltered granules with the ground and milled charcoal. These tests were carried out similarly to the previous test however lower concentration of 10 ppb was used. After 20 hours of exposure the granule samples, as previously, showed approximately a 10% reduction in silver content with the ground charcoal giving approximately 30% reduction in silver concentration and in the sample exposed to milled charcoal, approximately 60% reduction in silver concentration was observed. These tests found that increasing the surface area of the charcoal increased the silver reduction in the solution.

Conclusions: Data suggest that charcoal may be a suitable material for use in the capture of AgNPs from water samples